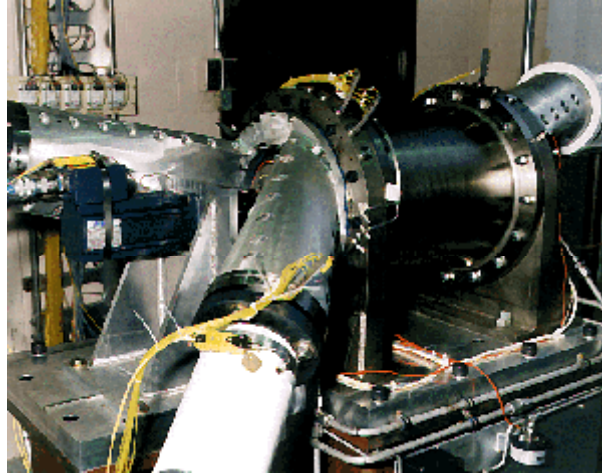


# Affect of Brush Seals on Wave Rotor Performance Assessed

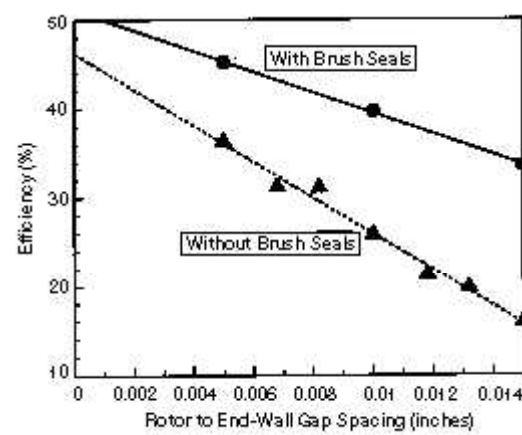


*Three-port wave rotor rig.*

The NASA Lewis Research Center's experimental and theoretical research shows that wave rotor topping can significantly enhance gas turbine engine performance levels. Engine-specific fuel consumption and specific power are potentially enhanced by 15 and 20 percent, respectively, in small (e.g., 400 to 700 hp) and intermediate (e.g., 3000 to 5000 hp) turboshaft engines. Furthermore, there is potential for a 3- to 6-percent specific fuel consumption enhancement in large (e.g., 80,000 to 100,000 lbf) turbofan engines (ref. 1). This wave-rotor-enhanced engine performance is accomplished within current material-limited temperature constraints.

The completed first phase of experimental testing involved a three-port wave rotor cycle in which medium total pressure inlet air was divided into two outlet streams, one of higher total pressure and one of lower total pressure. The experiment successfully provided the data needed to characterize viscous, partial admission, and leakage loss mechanisms. Statistical analysis indicated that wave rotor product efficiency decreases linearly with the rotor to end-wall gap, the square of the friction factor, and the square of the passage of nondimensional opening time. Brush seals were installed to further minimize rotor passage-to-cavity leakage. The graph shows the effect of brush seals on wave rotor product efficiency.

For the second-phase experiment, which involves a four-port wave rotor cycle in which heat is added to the Brayton cycle in an external burner, a one-dimensional design/analysis code (ref. 2) is used in conjunction with a wave rotor performance optimization scheme (ref. 3) and a two-dimensional Navier-Stokes code (ref. 4). The purpose of the four-port experiment is to demonstrate and validate the numerically predicted four-port pressure ratio versus temperature ratio at pressures and temperatures lower than those that would be encountered in a future wave rotor/demonstrator engine test. Lewis and the Allison Engine Company are collaborating to investigate wave rotor integration in an existing



turboshaft engine.

Recent theoretical efforts include simulating wave rotor dynamics (e.g., startup and load-change transient analysis, see ref. 5), modifying the one-dimensional wave rotor code to simulate combustion internal to the wave rotor, and developing an analytical wave rotor design/analysis tool based on macroscopic balances for parametric wave rotor/engine analysis.

*Brush seals have been added to the three-port rotor experiment. These seals prevent leakage from the passages to the surrounding cavity but do not affect circumferential (i.e., passage to passage) leakage. The seals improved the performance significantly at large values of the rotor to end-wall gap spacing, but they had less of an effect at small values of gap spacing.*

## References

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